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A STUDY OF THE RELATIONSHIP OF CERTAIN OCULOMOTOR SKILLS TO READING READINESS.

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DESCRIPTORS- *EYE MOVEMENTS, *READING ACHIEVEMENT, *READING READINESS TESTS, *READING READINESS, *PRESCHOOL CHILDREN, KINDERGARTEN CHILDREN, GRADE 1, METROPOLITAN READINESS TESTS, COLUMBIA, SOUTH CAROLINA

A "READING EYE" CAMERA PHOTOGRAPHED THE EYE MOVEMENTS OF 46 KINDERGARTEN CHILDREN OF MIDDLE-RANGE INTELLIGENCE. MOVING TARGETS WERE USED IN ORDER TO MEASURE OCULOMOTOR SKILLS--(1) OCULAR MOBILITY OR FREEDOM OF MOVEMENT OF THE EYES, (2) ACCURACY OF FIXATION, AND (3) VISUAL CONVERGENCE AND FUSION. SCORES FROM THE METROPOLITAN READINESS TESTS, FORM R, WERE USED AS A MEASURE OF READINESS FOR READING. THE METROPOLITAN ACHIEVEMENT TESTS ALSO WERE ADMINISTERED IN THE LATTER HALF OF THE FIRST GRADE. A FORTRAN PROGRAM WAS USED TO CALCULATE PEARSON PRODUCT MOMENT CORRELATION COEFFICIENTS. IT WAS CONCLUDED THAT THERE WAS NO SIGNIFICANT RELATIONSHIP BETWEEN OCULOMOTOR SKILLS OF CHILDREN OF MIDDLE-RANGE INTELLIGENCE AS MEASURED IN THIS STUDY, TO READING READINESS OR READING ACHIEVEMENT. (JM)

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COOPERATIVE RESEARCH PROJECT NO. S-211

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by

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INTRODUCTION

Good vision is more than visual acuity, or the ability to discriminate detail. Visual acuity is only one of the numerous visual skills necessary. Others include fusion skills, color discrimination, and binocular coordination which is the using of the two eyes as an efficent team. The sum of these skills is called vision.

Since reading depends on seeing words and interpreting them, the visual process is a natural part of the reading act, and a malfunction in vision can reflect itself in reading.

In the field of reading, authorities disagree on the importance of visual skills in relation to reading achievement. Discussing the effects of vision on reading achievement, Betts[1] states that attempts to predict reading ability merely on the basis of certain tests of seeing have never been successful. Certain visual defects such as myopia, in small degrees, may be positively related to reading achievement. Myopia is commonly called nearsightedness, and this condition results in a person being visually comfortable seeing hand-held print and visually

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[1]Emmett A. Betts, Foundations of Reading Instruction (New York: American Book Co., 1954), p. 175.

uncomfortable while viewing distant objects. It follows that a student with myopia may achieve better efficiency at near point tasks than at far point tasks.

Reporting has investigations of the literature, Russell[2] saw little agreement in different studies of visual skills related to reading achievement. He reviewed the studies relating acuity, refractive errors, binocular co-ordination, fusion, and six visual fields to reading achievement. He found no conclusive studies.

Spache[3] found that functional difficulties of the visual system did affect reading achievement. A defective pattern of eye movement is reflected in such reading performance difficulties as repeated loss of place, omissions, excessive repetitions and slow rates.

De Boer and Dallman[4] noted that almost all readers with visual problems would probably improve their reading ability if they corrected these defects. These authors also feel that teachers should be alerted to signs of visual difficulties among their pupils.

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[2]David H. Russell, Children Learn to Read (Boston: Ginn and Co., 1961), p. 99.

[3]George D. Spache, Reading in the Elementary School (Boston: Allyn and Bacon, 1964), p. 11.

[4]John J. De Boer and Martha Dallman, The Teaching of Reading (New York: Henry Holt and Co., 1960), p. 27.

A child's visual skills develop early. If these skills are not made efficient at an early age, they may play an important part in producing a lack of readiness to read. In many cases, defects in visual skills accompany other incompletely developed physiological factors. The combination tends to produce immaturity and to accentuate the difficulty in learning to read.[5]

Various ways have been studied to show a relationship between vision and reading achievement. Few significant relationships between these two were found when the research method included testing entire school populations. Results have been more fruitful when the comparison made is between the ocular characteristics of groups of very good readers and groups of very poor readers.[6]

Before the entire picture of the place of vision in reading achievement is clear, more research is needed. With the Federal Government increasingly interested in reading research, some emphasis probably will be in this direction. A recent publication[7] of the Office of Education of the Department of Health, Education, and Welfare suggested some study be made of visual difficulties not

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[5]Monroe J. Hirsch and Ralph E. Wick (Eds.), Vision of Children (Philadelphia: Chilton Co., 1963), p. 371.

[6]Ibid., p. 376.

[7]Doris V. Gunderson, Research in Reading Research, U. S. Department of Health, Education, and Welfare OE-30013 Bulletin 1964, No. 8 (Washington, D. C.: U. S. Government Printing Office, 1964), p. 34.

detected by screening devices used in the schools in relation to beginning reading. In a few years, we hopefully will not find as much disagreement as is now reflected in a review of research about the importance of visual skills in reading achievement.

There are, however, certain basic ideas that have been derived from the various studies of vision which appear to have general validity and application.

Vision development cannot be separated from the general field of human development. As the visual process develops, an integral part is the relationship to other parts of the body. Included in this is oculo-motor muscle development, hand-eye co-ordination, and the learning of spatial relationships. This interplay of physical function, including vision, characterizes human development. These developmental tasks require readiness.

Readiness is an essential factor in any phase of learning, and if the individual is to learn, some foundation for that learning must be established. Authorities agree that readiness in the visual mechanism is necessary for success in reading. Spache[8] suggests that visual skills for the young child are the most significant factors in early reading success.

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[8]George D. Spache, Reading in the Elementary School (Boston: Allyn and Bacon, 1964).

The visual ability of children entering the first grade of school varies as greatly as any other factor, and there are many individual differences. Monroe and Rogers state:

> The visual abilities of five and six-year-olds vary greatly at the time of school entrance, partly because of physical differences and partly because of the differing experiences the children have had. Some children have developed habits of careful observation and scrutiny of details. Others have learned to reach only to the gross visual differences among objects in their environment. Those children who have enjoyed many opportunities for interesting play with manipulative toys during their pre-school life have, in most cases, developed considerable ability to adjust their eyes and hold their attention to close work. Children who have lacked toys and equipment for manipulation are especially in need of manipulative activities and experiences at school.[9]

Vision develops like any of the other learned functions of the body. If a function is to develop it needs to be subject to stimulus activation. There is a controversy as to which is more important, maturation or experience, but it is agreed that both are important for vision to become efficient. There have been many studies on the observance of lack of stimulation resulting in a child not being ready to start school when he should chronologically.

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[9]Marion Monroe and Bernice Rogers, Foundations for Reading, informal pre-reading procedures (Chicago: Scott, Foresman & Co., 1964), p. 94.

Many times these children are the culturally deprived. Usually these culturally deprived children have language retardation in addition to visual retardation. They have not been exposed to books, magazines, or drawing materials which develop hand-eye co-ordination and fine motor development. Programs are being initiated under the Operation Headstart program to give many culturally disadvantaged children vital experiences needed so that they can successfully compete with children who have had normal learning experiences. While crash programs to induce readiness do not take the place of the experiences normally organized in the home, tentative reports suggest some positive result. The readiness skills that are emphasized are hand-eye co-ordination, visual motor skills, and visual perception skills.

The present study attempts to determine the importance of certain levels of oculo-motor skill development in reading readiness for beginning first grade students and to relate these beginning vision skills to reading achievement at the conclusion of first grade reading instruction.

Gesell[10] states that ocular pursuit activity is among the first visual skills to develop: "Rudimentary

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[10]Arnold Gesell, Frances L. Ilg, and Glenna Bullis, Vision, Its Development in Infant and Child (New York: Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, 1950), p. 189.

ocular pursuit is readily elicited in the first day of life by moving fluttering fingers slowly across the field of vision, with a distance of several inches from the eyes."

Since activity involving pursuit is one of the primary oculo-motor skills, and is one of the factors observed in the present study, it seems logical to say that what is being studied is a basic foundation of vision, and how it relates to later, more detailed visual and intellectual skills.

CHAPTER I

RELATED LITERATURE

In 1959, a paper was submitted for publication by Kephart, Manas, and Simpson[1] on "Vision and Achievement in Kindergarten." This study used the Keystone telebinocular vision skills battery in addition to four measures of motor control of the eyes. These measures were subjective in nature and were graded on a five point rating scale by the observer. The school achievement score was obtained by the Matropolitan Readiness Test, kindergarten level. Sixty-two children in the kindergarten of the public schools of Lafayette, Indiana, served as a control group. A positive relationship was found between the visual skills, as measured in this manner, and achievement, as measured by the Metropolitan Readiness Test. The paper concluded by suggesting that Kindergarten children would benefit from vision training and that by increasing their visual skills they would increase their achievement. The present study attempts to better control the measurement of oculo-motor development by using the Reading Eye Camera to record the eye movements and to objectively measure the results.

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[1]N. C. Kephart, Leo Manas, and Dorothy Simpson, "Vision and Achievement in Kindergarten," American Journal of Optometry and Archives of American Academy of Optometry, January, 1960, p. 50.

Regan and Croplay[2] studied the cultural influence on the oculo-motor system. Three series of motor tests were administered to experimental groups representing three levels of training in the reading and writing skills of our culture, and responses scored to indicate the extent of preference for left to right working was more strongly established with increasing literacy. This study indicates that our culture influences oculo-motor development, and that subjects from different social classes could possibly be at different developmental levels in oculo-motor skills because of the use of written materials in their environment.

A recent study by Stanford E. Taylor, H. Alan Robinson, and Miles Tinker[3] was "The Relationship of the Oculo-Motor Efficiency of the Beginning Reader to His Success in Learning to Read." This research program, although partially completed, is still following the same children in a longitudinal study. The purpose of the study was to explain differences in the oculo-motor behavior of kindergarten and/or first grade children, as revealed by eye-movement photography, and relating these differences to the individual competence of each child as

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[2]J. O. Regan and A. J. Croplay, "Language Conventions and Perceptual Learning," (unpublished manuscript distributed by authors, University of Alberta.

[3]Stanford E. Taylor, H. Alan Robinson, and Miles Tinker, The Relationship of the Oculo-Motor Efficiency of the Beginning Reader to His Success in Learning to Read (New York: Educational Developmental Laboratories, 1963).

he progressed through the first year or two of reading instruction. The study employed the Reading Eye Camera for eye-movement photography with the children instructed to look at stationary targets in various ways to indicate eye movements. The study measured motility, accuracy of fixation, and binocular co-ordination among other skills. These entering oculo-motor skill scores were compared to reading achievement at the end of the school year, and a positive relationship was found. However, since this study is still incomplete, final, exact results are not available. From the study of eye-movement data gathered to date, it would appear that a child enters school with a rather habitual oculo-motor activity derived from his accumulated "looking" experience. This study varies from the present study in that the abilities measured by Taylor, Robinson, and Tinker were initiated by the subject as he viewed a non-moving card as a result of instruction, while the present study only instructs the subject to watch a moving red ball, and the ability of the child to keep up with it is what is measured.

Tinker[4] found no significant correlation between reading proficiency and either accuracy of visual fixation in terms of number and extent of corrective moves at fixation point or speed of convergency-divergency moves.

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[4]Tinker, Miles A., "The Study of Eye Movements in Reading," Psychological Bulletin Vol. 43, No. 2 (March, 1946), p. 99.

Only when extremes of the group were compared was there a slight relationship evident.

Dorothy Simpson,[5] in her doctoral thesis "Perceptual Readiness and Beginning Reading," sought to determine the relative contribution of perceptual ability to first grade reading achievement and to assess the effectiveness of certain perceptual training activities in improving reading instruction. She divided her total group into a control group and an experimental group which was given perceptual training. She found that the experimental group achieved 3.33 months better than the control group in reading.

Included in her perceptual training of the control group were oculo-motor exercises to better develop this faculty. She referred to Hebb,[6] who indicated the probability that in the early stages of learning to perceive simple basic forms, the eyes must first be able to follow a straight line. The stable, clear, and effective perception of a circle or of a square requires, at least initially, controlled, accurate, eye movement.

Frostig, Lefever, and Whitlessey[7] recently completed a study entitled "Disturbances in Visual Perception."

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[5]Dorothy Margaret Simpson, "Perceptual Readiness and Beginning Reading," (A doctoral thesis presented to Purdue University, Lafayette, Indiana, 1960).

[6]Dio Hebb, The Organization of Behavior (New York: John Wiley & Sons, 1949).

[7]Marianne Frostig, Welty Lefever, and John Whitlessey, "Disturbances in Visual Perception", The Journal of Education Research, Vol. 57, No. 3 (November, 1963), pp. 160-162.

This paper describes a developmental test of visual perception: eye-hand co-ordination, figure-ground perception, form constancy, position-in-space, and spatial relationships. The results of testing 1800 pre-school and school children in a number of school districts indicates that the test seems effective in assessing the developmental status of these children. A low P. Q. (perceptual quotient) may indicate either delayed maturation or an actual injury to the structure of the central nervous system. It may also be a characteristic brought about by an interplay of genetic and environmental factors.

In the five areas of visual perception tested, a clear evidence of age progression was found from three years of age to about seven and one-half, but with little development evident after that age. The findings also show a relationship between disabilities in visual perception and poor classroom adjustment at the lower age levels. Many children referred to a special education program for the neurologically handicapped performed poorly on this test; data suggests that this test may also be useful in the diagnosis of neurological impairments. A longitudinal study of children scoring low in visual perception in the pre-school and kindergarten years is to follow this study. Although this research did not specifically study oculo-motor skills, these skills are part of the developmental framework of perception, and are related to the entire field of vision.

Gesell,[8] in his extensive observations of the development of vision in the infant and child, stressed the part vision plays in its directive role on motor development. He suggests periodic visual examinations for young children, not so much to determine refractive errors, but to evaluate developmental factors which are responsible for visual achievement. "These developmental factors are foreshadowed in the pre-school period, because basically even reading may be regarded as a complex task in the field of spatial manipulation." Thus he further states that these functions of development may well have a far-reaching effect in the resolution of learning and of reading difficulties.

Kephart, in his studies of related research, indicated the importance of the early stages of the visual learning process when he wrote:

> Many children are coming into our schools lacking in basic perceptual-motor skills. As a result of this basic lack, they are less able to participate in the formal educational activities which are arranged for them....there is evidence that the efficiency of the higher thought processes can be no better than the basic motor activities upon which they are based.[9]

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[8]Arnold Gesell, Frances L. Ilg, and Glenna Bullis, Vision, Its Development in Infant and Child (New York: Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, 1950), p. 287.

[9]Newell C. Kephart, The Slow Learner in the Classroom (Columbus, Ohio: Charles E. Merrill, 1965), p. 19.

Havighurst,[10] in his extensive studies of developmental tasks, relates the time-sequences in human development to the roles which society expects of the individual. Thus knowledge of the rate of development of any given task, especially one so related to cultural expectancy as is vision with its associated performances, is of major importance. Havighurst suggested the relationship between development and the culture as involving certain roles around which the culture is organized. These take on special importance when the child fails to master one of them at the appropriate time. A permanent handicap may result.

Tinker and McCullough[11] agree to the developmental nature of vision stressing that a developmental factor must enter into any visual task which requires co-ordinated binocular eye movements. It is with the area of binocular and co-ordinated eye movements that this present study will deal.

Many studies have been made concerning the eye-

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[10]Robert J. Havighurst, Human Development and Education (New York: Longmans, Green & Co., 1953), p. 92.

[11]Miles A. Tinker and Constance M. McCullough, Teaching Elementary Reading (New York: Appleton-Century-Crofts, 1962), p. 63.

movement photography process. Both Miles A. Tinker[12] and Stanford E. Taylor[13] found that this method was highly reliable. Both Ballantine[14] and Gilbert[15] used this method to find that there was a growth factor in oculo-motor skills. Guy T. Buswell[16] and also Earl A. Taylor[17] demonstrated the high positive correlation of results from eye-movement photography and grade placement. As a result of these and many more studies, the "Reading Eye" instrument was selected to study the eye movements of the subjects.

In summary, previous studies have shown that there is a developmental process in vision, and that evidence of age progression in visual perception was found from three to

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[12]Miles A. Tinker, "The Reliability and Validity of Eye-Movement Measures of Reading," Journal of Experimental Psychology, Psychological Bulletin #31, Vol. 19, (1963), pp. 732-746.

[13]Stanford E. Taylor, "Grade Level Norms for the Components of the Fundamental Reading Skill," Educational Developmental Laboratories Research and Information Bulletin #3, (Huntington, New York: Educational Development Laboratories, 1960).

[14]Francis A. Ballantine, "Age Changes in Measures of Eye Movements in Silent Reading," Studies in the Psychology of Reading: Monographs in Education, No. 4, (Ann Arbor: University of Michigan Press, 1951), pp. 67-111.

[15]Luther C. Gilbert, "Functional Motor Efficiency of the Eyes and its Relation to Reading," University of California Publications in Education Vol. 11, No. 3, (Berkeley, California: University of California Press, 1953), pp. 159.231.

[16]Guy T. Buswell, "Fundamental Reading Habits: A Study of Their Developments," Supplementary Educational Monograph No. 21, (Chicago: University of Chicago Press, 1922).

[17]Earl A. Taylor, Eyes, Visual Anomalies, and the Fundamental Reading Skill, (New York: Reading and Study Skills Center, 1959).

about seven and one-half years, but with little progress in development after that age. Vision has been demonstrated as being closely related to motor development. Cultural influences on oculo-motor systems are demonstrated by the fact that left to right preferences in oculo-motor movements are predominant in societies that use this direction for their printing. The relationship of vision skills to reading achievement was studied by Kephart, Manas, and Simpson[18] and they found a positive relationship between oculo-motor development and reading readiness. This sample was an average school group, and their findings were contrary to Tinker's[19] findings that correlations between measures of oculo-motor efficiency and reading achievement in normal populations had never been very high. One explanation for the positive correlation of oculo-motor development to reading readiness could be the method that was used to measure the level of oculo-motor development.

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[18]N. C. Kephart, Leo Manas, and Dorothy Simpson, "Vision and Achievement in Kindergarten," American Journal of Optometry and Archives of American Academy of Optometry, January, 1960.

[19]Miles A. Tinker, "The Reliability and Validity of Eye-Movement Measures of Reading," Journal of Experimental Psychology, Vol. 19, (1936).

Kephart, Manas, and Simpson used an observer and a rating scale for subjective findings. The present study attempts to achieve greater objectivity by using the "Reading Eye" camera to photograph the eye movements, and by scoring the films by a pre-determined method. The "Reading Eye" camera was selected since its validity and reliability had already been established and the instrument was easily converted for this use by the addition of moving targets. Taylor, Robinson, and Tinker[20] demonstrated the use of the "Reading Eye" instrument in a study of oculo-motor skills of pre-school and primary grade children. They measured the relationship of subject-initiated eye movements to reading achievement, thus measuring what the child actually did with his visual skills, while the present study measured what the child was capable of doing.

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[20]Stanford E. Taylor, H. Alan Robinson, and Miles Tinker, The Relationship of the Oculo-Motor Efficiency of the Beginning Reader to his Success in Learning to Read (New York: Educational Developmental Laboratories, 1963).

CHAPTER II

EXPERIMENTAL PROCEDURE

General Design

The subjects for the study were selected near the end of the school year from among children enrolled in a private kindergarten. There was an attempt to select a middle group with average intelligence and no visual, emotional, or physical problems. The Van Alstyn Picture Vocabulary Test[1] was the instrument used to screen out the extremes in intellectual ability. For measuring the oculo-motor skill development at the beginning of first grade, the Reading Eye Camera[2] photographed reflections from the subjects' eyes. This camera was equipped with specially designed moving targets to test the oculo-motor skills. The Metropolitan Readiness Test[3] was then administered to the subjects at the beginning of first grade, and scores were tabulated for each part of the test and totaled to

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[1]Van Alstyn Vocabulary Test, (New York: Harcourt, Brace and World), 1961.

[2]Metropolitan Readiness Tests, (New York: Harcourt, Brace, and World), 1950.

[3]The Reading Eye and Educational Developmental Laboratories, (New York: Huntington), 1959.

obtain the reading readiness score. When the selected subjects were near the end of first grade, the Primary I Battery, Metropolitan Achievement Test,[4] form B, was given, and scores for the reading area were recorded. The data from these several tests were collected and a Fortran program was selected for calculating Pearson Product Moment Correlation Coefficients. The University of South Carolina (IBM #7040) Computer was utilized to produce four tables of interrelations including a 15 x 15 matrix and related values. Utilizing the Fisher tables from Underwood[5] the value of "t" was determined at the 1% and 5% level of significance for each correlation.

Population and Samples

The population consisted of white middle-class children who attended a private Kindergarten, and who initially enrolled for first grade in the public schools in the Columbia, South Carolina area, in September, 1964. Columbia, South Carolina is a typical southeastern city with approximately 100,000 residents. The sample size was forty-six; twenty-two boys and twenty-four girls. The chronological age at the beginning of the school year varied from

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[4]Metropolitan Achievement Tests, Primary I Battery, (New York: Harcourt, Brace, and World), 1959.

[5]Benton U. Underwood, Carl P. Duncan, Janet A. Taylor, John W. Cotten, Elementary Statistics (New York: Appleton-Century-Crofts, Inc., 1954).

five years, eleven months to six years, ten months. None of the subjects had any apparent physical, emotional, or visual problem, and none wore glasses. A middle intellectual group was desired so a picture-vocabulary test was given, and the sample was drawn from the middle group of scores. Subjects with I.Q. scores of less than 90 or more than 135 as measured by the Van Alstyn Picture Vocabulary Test were not considered in this study since it was believed that extremes in intelligence would tend to create too heavy a weighing for intelligence as a factor determining reading aptitude. Although the subjects all attended the same Kindergarten, their first grade instruction was in five different elementary schools. During the school year three of the subjects moved out of the area, resulting in reading achievement scores not being secured for these children.

Measuring Instruments

The Van Alstyn Picture Vocabulary Test

The Van Alstyn Picture Vocabulary Test provides an estimate of the mental ability of children in the mental age range from two to seven years. The estimate of mental ability is based on the child's vocabulary comprehension. The test materials consist of a spiral-bound booklet containing sixty cards, on each of which are four pictures. The child is asked to respond to each of the cards by indicating the picture which illustrates a stimulus word or

phrase presented orally by the examiner. The test claims a reliability score of 0.76 and a validity score of 0.69 when compared to the Stanford Binet for children from ages 5.0 to 5.11. This test was given to seventy-two kindergarten students, and the middle group of forty-six was selected to continue the study. No child was retained in the research group who scored lower than 90 or more than 135.

Metropolitan Readiness Tests, Form R

The Metropolitan Readiness Tests were devised to measure the traits and achievements of school beginners that contribute to their readiness for first grade instruction. Designed for testing pupils at the end of the Kindergarten year or the beginning of the first grade, these tests are contained in a sixteen-page booklet comprising six separate tests: Test one is Word Meaning, and measures the understanding or comprehension of language, although it is not a test of language usage. The subject is to select the picture that best illustrates the word the examiner names. Test two is Sentences, and is similar to test one except that the subject is required to comprehend phrases instead of individual words. Test three is Information, and is related to vocabulary. The subject is instructed to select from a row of four pictures the one that best suits the examiner's description. Test four is Matching, and is a test of visual perception involving the recognition

of simularities. The subject is to draw a frame around the picture that matches the one like it in the center of the row. Test five is Numbers, and measures achievement in number vocabulary, counting, ordinal numbers, recognition of written numbers, writing numbers, interpreting number symbols, the meaning of number terms, the meaning of fractional parts, recognitional forms, telling time, and the use of numbers in simple problems. This number knowledge was measured by using the picture form of materials and certain checking devices. Test six is Copying, and measures a combination of visual perception and motor control, similar to that required in learning to write. The subject was asked to copy items. This test purports to be measurative of readiness for reading. For tests one to six, the reliability coefficient is .89 and also for tests one to six, the total reading readiness validity is .534. This test was given the first two weeks of school by each of the classroom teachers as part of the school routine.

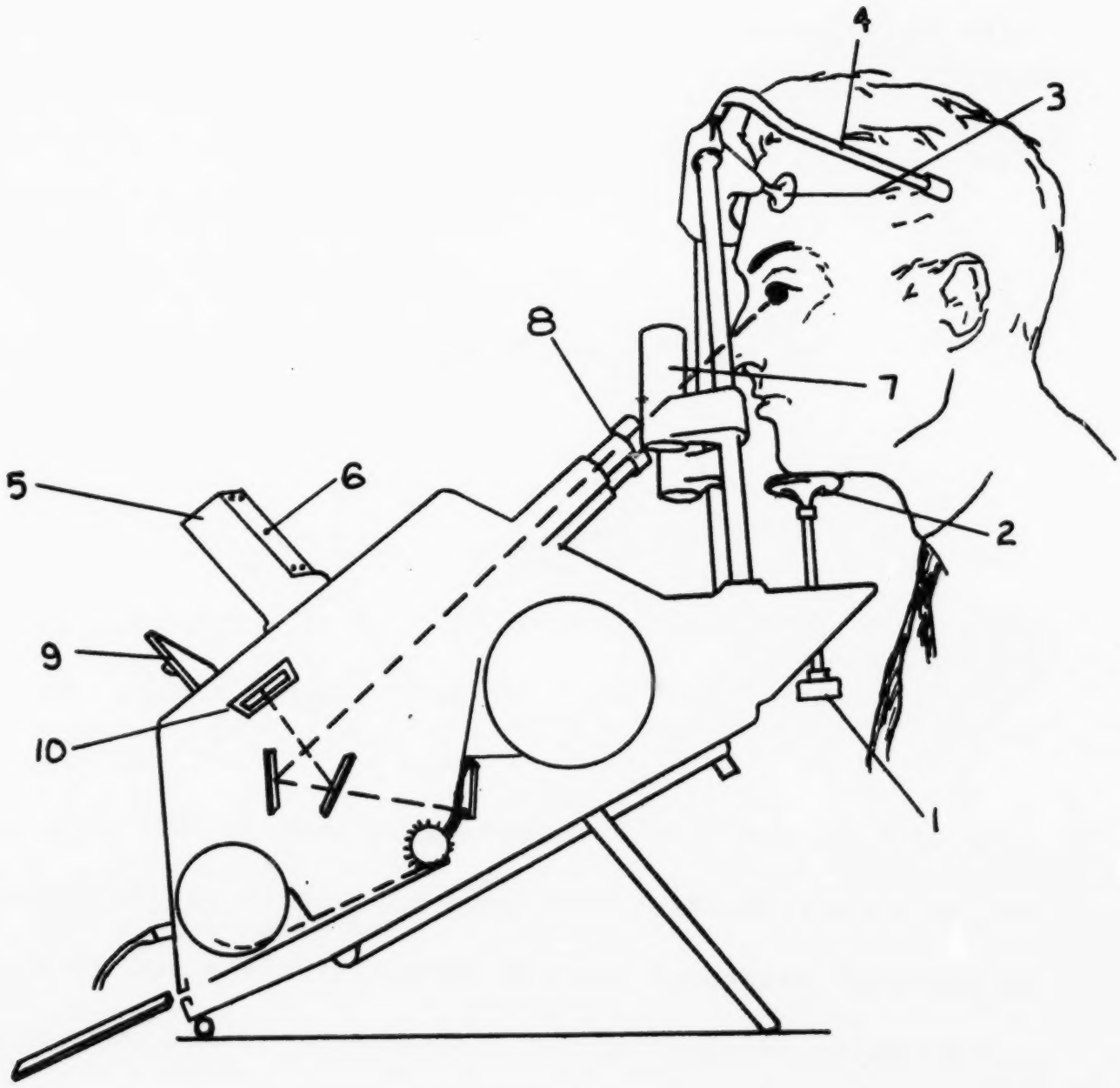
The Reading Eye

The Reading Eye is an eye movement camera distributed by Educational Developmental Laboratories, Huntington, New York. The instrument was designed to record a person's eye movements while reading. A reflection of the reading process is photographed on moving film, and through an analysis of the pattern that the eyes make on

the film, much can be learned about the organization and effectiveness of the subject's reading performance. Figure 1 shows the Reading Eye Camera and how it works. The following numbers are keyed to the numbers appearing in the drawing of Figure 1. (1) shows adjustment for the chin rest, (2) the subject places his chin on the chin rest, (3) the head rest pads against his forehead, (4) the head steadiers are positioned against his head, (5) the area of regard is the target, (6) with the red spots alternately being illuminated, (7) the recording lights are turned on, (8) causing beads of light to be reflected off the cornea of the eyes through the telescoping lenses, (9) the camera observes the reflection of these beads through the aperature door from the (10) ground glass that these beads of light come to a focus and are aligned for recording them. It is important to recognize that an eye movement photograph is primarily a reflection of performance and not of achievement, though obviously all factors of the individual's development influences a performance test. Analysis of eye-movement photographs reveals data that is objective, with factors that are directly measurable or "countable."

It was necessary to design moving targets in order to measure the oculo-motor skills and substitute these for the reading selections normally at the area of regard in order to convert the Reading Eye into an instrument that would satisfy the necessities of the present study. Three targets were designed by the author and built by the

FIGURE 1
EYE - MOVEMENT CAMERA

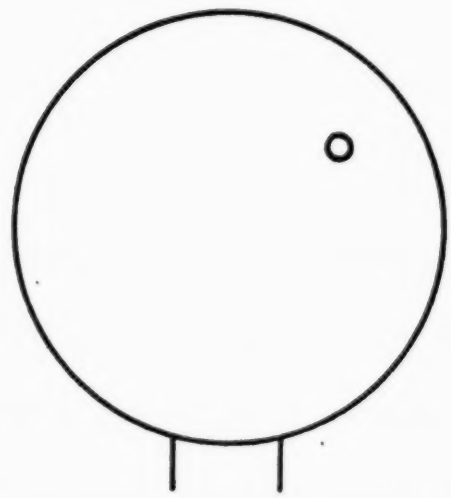


Colonial-Hites Company, West Columbia, South Carolina.

The first target measured rotational pursuits. This involves ocular mobility, or freedom of the movement of the eyes. The circular target was built of aluminum with a black satin face and a red illuminated fixation spot that rotated slowly clockwise. Figure 2 illustrates this target.

FIGURE 2

ROTATIONAL PURSUIT TARGET

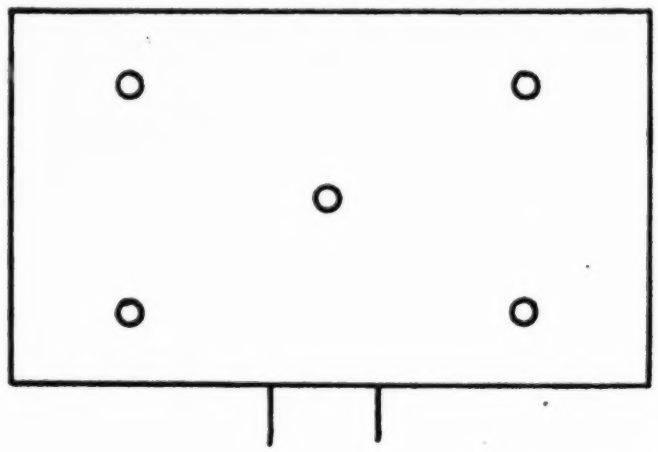


The second target measured accuracy of fixation, or the ability to direct the eyes with relative precision, or to carry out a visual survey without excessive fixation or corrective ocular movements. The rectangular target was also made of aluminum with a black satin face with a red illuminated fixation spot that alternately appeared in each

corner and in the center in a random pattern. Figure 3 illustrates this target.

FIGURE 3

ACCURACY OF FIXATION TARGET

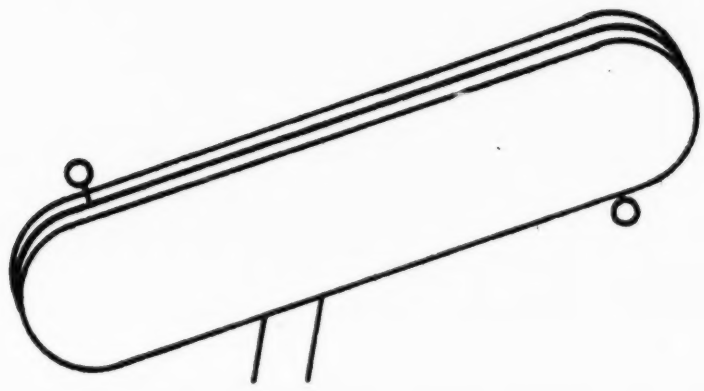


The third target was designed to measure visual convergence and fusion. Convergence is the act or power of turning the eyes inward from their normal position of rest so that the image of a near object will fall on corresponding parts of the retina in each eye. Fusion is the mental blending of the right and left eye images into one composite image. This target was also made of aluminum with two red fixation objects attached, only one of which can be seen by the subject at the time the visual experience is perceived by the subject as follows. The first fixation object moves slowly from the far end of the target to the near end, then disappears and the other fixation object appears at the far end and then moves closer to the subject in a

continuous action. Figure 4 illustrates this target.

FIGURE 4

VISUAL CONVERGENCE AND FUSION TARGET



In order adequately to photograph the eyes of the six-year-old subjects, two person's assisting the children were utilized. One person operated the camera, and the second assisted the child and helped maintain him in the correct position during the test. Even with this care, a number of children had to be re-tested since they moved their heads, or their eyes were malaligned in some manner during the photography. Good rapport was built up between the testers and the subjects, and the tests were carried out in a game-like fashion. The child was instructed to watch the red lights, or in the case of the third target, the red ball. The moving targets were given the following nicknames: 1) ferris wheel, 2) flashing lights, and 3) the zoot de zoot. As the child was seated before the Reading

Eye Camera his chin was placed on the chin rest, and his forehead against the headrest pads. The head steadiers were swung into position against each side of his head, and his head also was gently held by the hands of one of the testers' assistants. (The steadiers are the devices provided by the manufacturer to assure correct positioning.) As the subject looked at the area of regard, recording lights caused beads of light to reflect on the cornea of his eyes. These beads of light passed through telescoping lenses to a mirror from which they were deflected upwards to a reflex aperture so the camera operator could align and focus them for recording on the film. To record, the reflex aperture door was closed, the recording lights dimmed automatically, and the film moved at a predetermined continuous rate from the film supply spool through the exposure area into a take-up magazine. Each child had a film record made for each of the three targets. The film was developed by a commercial film processor.

Typically, the film for the various targets would follow the pattern of these illustrations if the child had excellent oculo-motor skills. Figure 5 illustrates a model film of rotational pursuit skills. As the target for rotational pursuit skills rotated, the two eyes acted as a team and should show the same distance apart throughout the film, with few regressions, or time off the fixation

object. The photographs showed an undulating pattern.

FIGURE 5

FILM TRACE OF ROTATIONAL PURSUIT SKILLS

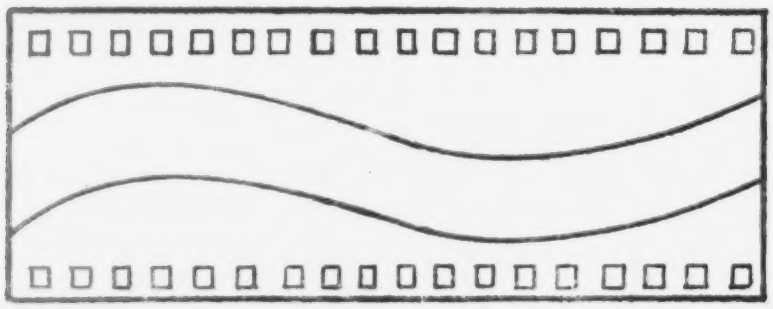


Figure 6 illustrates a model film of accuracy of fixation skills. As the target for accuracy of fixation skills is flashed alternately, the eyes should work as a team, with the patterns showing same distance throughout with few regressions, and little time off the fixation object. The photographs showed a jerky-step pattern.

FIGURE 6

FILM TRACE OF ACCURACY OF FIXATION SKILLS

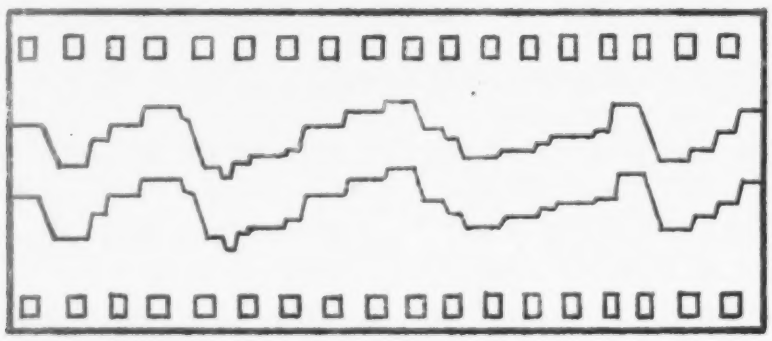
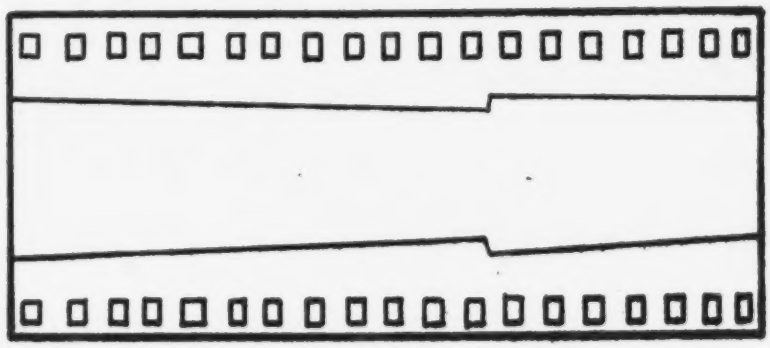


Figure 7 illustrates a model film of visual convergence and fusion skills. As the fixation object for the target measuring convergence and fusion skills moved closer to the subject, the distance between the pattern decreased. The pattern was a convergence of the lines until the fixation object disappeared. With good visual habits there should be few regressions or time off the fixation object.

FIGURE 7

FILM TRACE OF VISUAL CONVERGENCE AND FUSION SKILLS



For grading the film, or scoring existing visual skills, the same method was used in each of the three parts of the film. The films were examined carefully, and the best area of one inch of each of the three parts was selected and marked off. The total regressions were counted, and the percentage of times the eyes were off the fixation object was estimated. Each percentage off the target counted one half point, and each regression counted one point. The sum of these two was subtracted from a

constant value of fifty to arrive at a score. Each target was scored separately, and then added for a total score. This method was established for ease of counting and uniform handling of results.

Metropolitan Achievement Tests:

Primary I Battery, Form B

This battery of tests was designed to be used in the latter half of first grade. The size of types, and the length of lines in the reading selections reflect corresponding characteristics of the instructional materials commonly used in the first grade. The content was designed to be well within the range of the pupils interests and experiences. The first three tests measured reading skills, and these were the only tests completed for this study. Test one was Word Knowledge, and this measured the child's sight vocabulary, or word recognition ability. The words tested were selected from words occuring with greatest frequency in beginning reading materials. Test two was Word Discrimination, and measured the child's ability to select an orally presented word from among a group of words of similar configuration. Test three was Reading, and was in two parts. In the first part the child had to demonstrate his ability to read and to understand sentences by choosing the correct sentence to match a picture. The second part measured the ability of the child to comprehend materials of a paragraph length, with questions about the

selection. These tests were given in the last month of school. The reported reliability of the Word Knowledge subtest was .90, the Word Discrimination subtest .87, and the Reading subtest, .92.

CHAPTER III

RESULTS

INTRODUCTION

The data collected from the tests were collected and a Fortran Program was selected for calculating Pearson Product Moment Correlation Coefficients. (The I.B.M. #7040) computer of the University of South Carolina was utilized to produce four tables of interrelations including a 15 x 15 matrix and related values. Level of significance for each correlation was tested to determine if a 1% or 5% correlation of scores for the study, while tables one through three were derived from Table Four to better illustrate specific correlation coefficients.

Correlations of Oculo-Motor Skill Scores With Reading Readiness Scores

Table One shows the correlation coefficients obtained when forty-six first graders subtest and total scores on the Metropolitan Readiness Test were correlated with the oculo-motor test and total scores.

Correlation of Oculo-Motor Skill Scores With Reading Achievement Scores

Table Two shows the correlation coefficients obtained when forty-three first graders' subtest and total scores on the oculo-motor test were calculated with the subtests of the Metropolitan Achievement Test.

Inter-Correlation of the Oculo-Motor Skill Scores

Table Three shows how well the subtest of the oculo-motor skill test correlated with one another and with the total oculo-motor test score.

Total Inter-Correlation of Scores

Table Four shows the total inter-correlation of scores for the study.

Fairly low correlation coefficients resulted when the oculo-motor skill scores were related to reading readiness subtest scores. When correlating the oculo-motor skills to subtests, the results are fairly low correlations. Only three of the correlations are significant to the 5% level, and one of these is a negative correlation. There was no correlation coefficient that was significant to the 1% level. The most important finding in this group as listed in Table One was the total of the reading readiness scores. This result was 0.10, and was significant to the 5% level, and could be interpreted as a no difference correlation. It was interesting to note

TABLE 1

Correlation Coefficients For Oculomotor Skill Scores

With Reading Readiness Scores

Subtests of Metropolitan Readiness Test	Saccatics	Rotations	Convergence	Total Score
Word Meaning	.27	.06	.04	.11
Sentences	.06	-.07	.03	.08
Information	.33	.23	.23	.29
Matching	.14	.01	.36	.17
Total Tests 1-4	.23	.03	.24	.20
Numbers	-.07	-.39	-.02	-.23
Copying	.22	.03	.08	.12
Total Score	.19	-.08	.17	.10

TABLE 2

Correlation Coefficients For Oculomotor Skill Scores

With Reading Achievement Scores

Subtests of the Metropolitan Achievement Test	Saccatics	Rotations	Convergence	Total Oculomotor Score
Word Knowledge	.02	-.17	.05	-.06
Word Discrimination	-.006	-.19	.0009	-.10
Reading	.20	-.24	.01	-.07

TABLE 3

Intercorrelations of Oculomotor Skill Scores

	Saccatics	Rotations	Convergence	Total Oculomotor Score
Saccatics	1.00	.51	.48	.77
Rotations	.51	1.00	.39	.83
Convergence	.48	.39	1.00	.76
Total Oculomotor Score	.77	.83	.76	1.00

TABLE 4

INTERCORRELATIONS OF ALL SCORES

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1.00	.38	.27	.41	.69	.43	.21	.66	.27	.06	.04	.11	.14	.15	.29
2	.38	1.00	.17	.21	.68	.39	.21	.60	.06	-.07	.03	.08	.24	.30	.24
3	.27	.17	1.00	.28	.43	.11	.30	.42	.33	.23	.23	.29	.09	.08	.22
4	.41	.21	.28	1.00	.74	.33	.39	.70	.14	.01	.36	.17	.30	.33	.41
5	.69	.68	.43	.74	1.00	.47	.45	.92	.23	.03	.24	.20	.31	.40	.45
6	.43	.39	.11	.33	.47	1.00	.18	.65	-.07	-.39	-.02	-.23	.27	.27	.39
7	.21	.21	.30	.39	.45	.18	1.00	.64	.22	.03	.08	.12	.10	.29	.28
8	.66	.60	.42	.70	.92	.65	.64	1.00	.19	-.08	.17	.10	.28	.41	.48
9	.27	.06	.33	.14	.23	-.07	.22	.19	1.00	.51	.48	.77	.02	.006	.20
10	.06	-.07	.23	.01	.03	-.39	.03	-.08	.51	1.00	.39	.83	-.17	-.19	-.24
11	.04	.03	.23	.36	.24	-.02	.08	.17	.48	.39	1.00	.76	.05	.0009	.01
12	.11	.08	.29	.17	.20	-.23	.12	.10	.77	.83	.76	1.00	-.06	-.10	-.07
13	.14	.24	.09	.30	.31	.27	.10	.28	.02	-.17	.05	-.06	1.00	.80	.76
14	.15	.30	.08	.33	.40	.27	.29	.41	.006	-.19	.0009	-.10	.80	1.00	.74
15	.29	.24	.22	.41	.45	.39	.28	.48	.20	-.24	.01	-.07	.76	.74	1.00

KEY: Showing identity of tests in columns and lines in matrix above

1. Word Meaning - Metropolitan Readiness Test
2. Sentences - Metropolitan Readiness Test
3. Information - Metropolitan Readiness Test
4. Matching - Metropolitan Readiness Test
5. Total of Tests 1-4 - Metropolitan Readiness Test
6. Numbers - Metropolitan Readiness Test
7. Copying - Metropolitan Readiness Test
8. Total Score - Metropolitan Readiness Test
9. Saccatics
10. Rotations
11. Convergenced
12. Total Oculomotor Skills
13. Word Knowledge - Metropolitan Achievement Test
14. Word Discrimination - Metropolitan Achievement Test
15. Reading - Metropolitan Achievement Test

that the highest consistant correlation coefficients occurred with the Information subtest on the Metropolitan Readiness test and the various oculo-motor skills. Also the number subtest on the Metropolitan Readiness test correlated higher with the various oculo-motor skills. The number subtest of the Metropolitan Readiness test consistently resulted in a negative correlation with the oculo-motor skills.

The correlation coefficient of the oculo-motor skills to the subtests of the Metropolitan Achievement Test was even lower than the correlations coefficient of the oculo-motor skills to the Metropolitan Readiness Tests. The results show that none of the correlations are significant to the 5% level. The most important column in Table Two was the total oculo-motor score correlated to the various subtests. It was interesting to note that each was a very small correlation coefficient, and that each was a negative correlation coefficient. Another noteworthy fact was that the Rotation score negatively correlated with each of the subtest scores of the Metropolitan Achievement Test. The rotation score in Table One when correlated with the Metropolitan Readiness Test resulted in more negative correlation coefficients than any other oculo-motor skill scores. While these scores apparently don't correlate significantly with reading readiness scores, or reading achievement scores, they do correlate among themselves fairly well. Each of the

inter-correlation coefficients of the oculo-motor skill subtests are significant to the 1% level. There is very little difference in the subtests when trying to determine which of the subtests correlate the best with the others.

Table Four is the entire correlation matrix presenting the study as a whole. Table One, Two, and Three use parts of the Table Four total taken out for easier viewing.

CHAPTER IV

CONCLUSION

The oculo-motor skill scores when correlated to the Metropolitan Readiness Test, and to the Metropolitan Achievement Test result in a non-significant correlation coefficient. This is what would be expected according to Betts,[1] as reference was made to him in the Introduction. He stated there that attempts to predict reading achievement merely on the basis of certain tests of seeing have never been successful. From Tinker's[2] statement in Chapter I, we could also expect these results. He said that he found no significant correlation between reading proficiency and either accuracy of visual fixation measured in terms of number and extent of corrective moves at fixation points or speed of convergence-divergence moves. Only when extremes of the group were compared was there a slight relationship evident.

The sample studied was a middle group, and the results followed a pattern established by physical scores correlated to reading readiness and reading achievement.

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[1]Emmett A. Betts, Foundations of Reading Instruction (New York: American Book Co., 1954), p. 175.

[2]Miles A. Tinker, "The Reliability and Validity of Eye-Movement Measures of Reading," Journal of Experimental Psychology Vol. 19, (1936), pp. 732-746.

The oculo-motor function is physical in most respects when observed as this study did. The eyeball is controlled by six extrinsic muscles, and the ability to follow the moving targets was the ability to operate smoothly and co-ordinate these muscles. As stated in Chapter II, the only instruction given the subject was "Watch the red dot," or "Watch the red ball." This was an attempt to limit the intellectual part of the performance, and to concentrate on the physical area, that is, the oculo-motor skill. Possibly the positive results obtained by Kephart, Monas, and Simpson[3] could be attributed to the manner in which the study was conducted, and that the intellectual influence of vision was felt in the results. Vision, especially when the perceptual area of vision is thought of, could be related to the ability to follow directions, or to initiate visual action, and is related to intelligence; therefore a positive relationship could be expected with reading readiness and reading achievement. The Taylor, Robinson, and Tinker[4] study measured the ability of the subject to initiate oculo-motor action. Their study also involved recall of objects viewed previously and measured how often and how long the subject

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[3]N. C. Kephart, Leo Manas, and Dorothy Simpson, "Vision and Achievement in Kindergarten," American Journal of Optometry and Archives of American Academy of Optometry, January, 1960, p. 50.

[4]Stanford E. Taylor, H. Alan Robinson, and Miles Tinker, The Relationship of the Oculo-Motor Efficiency of the Beginner Reader to His Success in Learning to Read (New York: Educational Developmental Laboratories, 1963).

fixated on an object. This would involve more than merely the level of skill involved in following moving targets, but would include the skill of interpreting and following directions, speed of perception, and visual memory. These aforementioned skills are related to the intellectual area of vision, and it seems reasonable to assume that this area of vision would be closer related to reading readiness and reading achievement than a mainly physical area of vision. Although one cannot separate intellect from any area of vision, some areas are more effected than others. In the present study, when one area of vision, the physical area of the oculo-motor system, was observed, with a middle group sample, as this study attempted, there was no significant correlation with reading readiness or reading achievement.

These results could be interpreted as finding little value in giving vision training that emphasizes physical oculo-motor exercises in the schools at Kindergarten and first grade levels to all children, whether or not they have a vision defect. The study does not suggest that it would not be advisable to give visual training to a child who has a specific problem. Each child is an individual and each has his own level of visual skills. From this study, for the middle group of children, an individual is not handicapped academically if his oculo-motor visual skills are not as good as another in this group. Perhaps if other groups of children were studied, such as comparing

the academically retarded with the academically accelerated, different results would be obtained, but for the middle group there is no significant relationship of oculo-motor skills, as this study measured them, to reading readiness or reading achievement.

GLOSSARY

1. Accuracy of Fixation - The ability of directing the eyes with relative precision in carrying out a visual survey without corrective ocular movements or excessive refixations.

2. Binocular Coordination - The child's ability to carry out near-point visual surveys for both timed and untimed situations without losing vergence or horizontal or vertical control.

3. Convergence - The act or power of turning the eyes inward from their normal position of rest so that the image of a near object will fall on corresponding parts of the retina in each eye.

4. Extrinsic Muscles of the Eye - These muscles control the movement of the eyeball in its socket.

5. Fusion - The mental blending of the right and left eye images into one composite image.

6. Middle Group - The group remaining in the study after the extremes of intelligence were screened out.

7. Motility - The ability of the child to make ocular excursion in a quick or easy manner in carrying out visual surveys at near point.

8. Ocular Pursuits - The measures of ocular mobility, or freedom of the movement of the eye in an accurate and smooth manner.

9. The Ocular-Motor System - The motor system that controls the motility of the eye.

10. The Reading Eye - An eye movement camera distributed by Educational Developmental Laboratories, Huntington, New York.

11. Visual Memory - The number of picture objects recalled after specific periods of observations.

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